# W. R. Grace & Co.-Conn.
# Nickel Oxide Product Stewardship Summary

## I. Overview

Nickel oxide is a component in Grace hydroprocessing catalysts used by the petroleum industry for the refining of crude oil fractions like naphtha, kerosene and diesel under elevated pressure and temperature. These catalysts used are usually composed of oxides of Mo (Molybdenum), Co (Cobalt), Ni (Nickel), and W (Tungsten) on a matrix or carrier of alumina, silica or silica and alumina. Grace does not manufacture or supply pure nickel oxide.

## II. Chemical Identity-Physical and Chemical Properties

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| CAS number: | 1313-99-1 |
| EINECS: | 215-215-7 |
| RTECS number: | QR8400000 |
| Molecular formula: | NiO |
| Molecular weight: | 74.69 |
| Synonyms: | Nickel(II) oxide; Nickel monoxide; Nickelous oxide, Green nickel oxide, Black nickel oxide and Mononickel oxide |

### Physical-chemical properties

- Nickel oxide is an odorless solid in the form of a black or green powder
- Density: 6.67 g/ml at 25°C
- Melting Point: 1960°C
- Solubility: practically insoluble in water (0.0000352 g/L at 20 °C (green nickel oxide), and 0.00226 g/L at 20 °C (black nickel oxide))

## III. Applications and uses of Nickel oxide

Nickel oxide has many uses the primary of which is in steel and alloy manufacturing. It is also used in the ceramics industry, in electronics, and as a chemical intermediate for catalyst purposes (e.g. for nickel containing hydroprocessing catalysts). Hydroprocessing catalysts are used in the refining industry within process reactors at

industrial locations to upgrade heavy oils into lighter, more useful products by removing impurities such as nitrogen, sulfur and heavy metals, allowing less expensive feedstock to be used in the petroleum refining process. Hydroprocessing is an important process necessary to remove pollutants like sulfur, nitrogen and heavy metals from fuel oils. The purpose of removing sulfur (hydrodesulfurization) is to reduce the sulfur dioxide ($SO_2$) emissions that result from using those fuels in vehicles, aircraft, ships, gas and oil burning power plants, furnaces and other forms of fuel combustion. The level of allowed sulfur content in fuels is regulated and can only be achieved by using such hydroprocessing catalysts. The desulfurization reaction takes place in a closed fixed-bed reactor at elevated pressure and temperature. Typically, a combination of nickel and molybdenum is used in combination with other forms of hydroprocessing catalysts. Nickel acts as a promoter to maintain the activity of the catalyst system.

## IV. Manufacturing Processes

Hydroprocessing catalysts are prepared at GRACE by supporting nickel in combination with other metals on a carrier material. This process is known as impregnation. Nickel is obtained by Grace from suppliers as nickel carbonate and is converted into a soluble form together with other ingredients. After impregnation, it is converted into the nickel oxide present on the surface of the carrier material. Hydroprocessing catalysts are typically supplied as extrudates or structured shapes such as asymmetric quadrilobes and spheres. Hydroprocessing catalysts supplied by Grace can be termed pre-catalysts because they must be sulfided to become active. Hydroprocessing catalysts as supplied by Grace are not highly reactive, flammable or explosive.

## V. Health Effects

Nickel and nickel compounds are abundant in the earth's crust. They occur naturally from weathering rocks, soils, and windblown dusts. Nickel in the environment is also a result of fossil fuel consumption, nickel mining, processing and scrap metal reclamation. Exposure to nickel occurs through inhalation, ingestion, and dermal contact.

Nickel oxide is considered carcinogenic to humans. Inhalation of nickel oxide dust can irritate the nose, throat, and lungs, and may cause difficulty breathing or an allergenic respiratory reaction. It can be irritating to the skin and eyes, and may cause skin sensitization, an allergic reaction, upon repeated or prolonged contact.

The health effects of nickel oxide are seen primarily where nickel oxide comes in direct contact with living tissue such as in the lungs, or as is seen in experimental models where nickel oxide is directly injected into the tissue of laboratory animals. When nickel oxide is inhaled in large quantities in experimental laboratory animals, it has been shown to cause inflammation and injury to the lung tissues. This is noted to be a cumulative effect over time and is dose related. This means that the greater amount of nickel oxide which is forced into the lungs of animals, the greater is this inflammatory reaction.

## VI. Environmental Effects

Nickel is ubiquitous in the environment and is introduced from both natural occurring nickel in the earth crust and from human sources. Nickel mining, processing, scrap metal reclamation, and burning of fossil fuels, account for most of the nickel in the environment related to human activity. Nickel in sufficient amounts in both fresh water and marine environments has been shown to be toxic to a variety of life forms including plant species. While nickel is an essential nutrient for a variety of mammals including humans and non-mammals, the concentration of nickel in the environment must be controlled to protect marine organisms, plants and higher animals. Nickel oxide is not soluble in water.

## VII. Conclusion

The primary risk of worker exposure to nickel oxide is by dust inhalation and by dermal contact. Exposure potential is controlled in industrial settings by use process enclosures, ventilation and personal protective equipment. Workplace exposure limits exist for nickel compounds in worksite safety programs. Since Grace hydroprocessing catalysts containing nickel oxide are only used under strictly controlled conditions in an industrial setting the risk of exposure to this source of nickel oxide to the general public is considered negligible.

## VIII. W. R. Grace Contacts

Please feel free to contact one of the following Grace representatives should you desire additional information or have questions.


Brett Jurd — Brett.Jurd@grace.com
Juergen Nolde — Juergen.Nolde@grace.com


## IX. References, literature and other sources of information


The International Agency for Research on Cancer **(**IARC) Nickel Oxide Monograph
http://monographs.iarc.fr/ENG/Monographs/vol100C/mono100C-10.pdf

The Nickel Institute
http://www.nickelinstitute.org/

Centers for Disease Control and Prevention
http://www.cdc.gov/niosh/npg/npgd0445.html

European Chemicals Agency registered substances webpage:
http://echa.europa.eu/web/guest/information-on-chemicals/registered-substances

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